(12) UK Patent Application (19) GB (11) 2 322 998 (13) A

(43) Date of A Publication 09.09.1998

(21) Application No 9703547.1

(22) Date of Filing 20.02.1997

(51) INT CL[6]
H04Q 7/38

(52) UK CL (Edition P)
H4L LDSC L1H10

(56) Documents Cited
GB 2280085 A WO 95/32592 A1 WO 92/02103 A1

(58) Field of Search
UK CL (Edition O) H4L LDSC
INT CL[6] H04Q 3/00 7/38
ONLINE: WPI

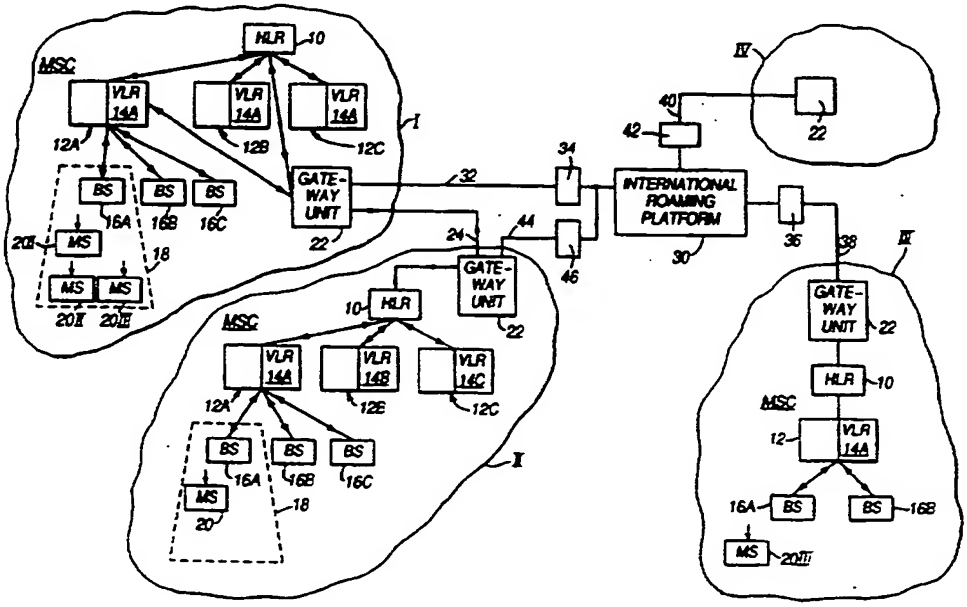
(71) Applicant(s)
Vodafone Limited
(Incorporated in the United Kingdom)
The Courtyard, 2-4 London Road, NEWBURY,
Berkshire, RG13 1JL, United Kingdom

(72) Inventor(s)
Gerry Cowan
John Boggis
Graham Rickett
Peter Zbaren

(74) Agent and/or Address for Service
Mathisen Macara & Co
The Coach House, 6-8 Swakeleys Road, Ickenham,
UXBRIDGE, Middlesex, UB10 8BZ, United Kingdom

(54) Abstract Title
Method of Interconnecting Communication Networks

(57) Networks III and IV have concluded service agreements with an international roaming platform (IRP 30) rather than bilaterally with networks I and III. When a subscriber (MS 20III) of one of these networks (III) is roaming in a visited network (I), a registration request is passed by the MSC (12A) of the visited network (I) to the international roaming platform (IRP 30) which checks that the visited network (I) and the home network (III) of the subscriber (MS 20III) have concluded service agreements with it and then passes the request to the home location register (HLR 10) of the home network (III). This home location register then produces authentication data which is transmitted by the international roaming platform (IRP 30) to the visited network (I) for authenticating the visiting subscriber (MS 20111). The subscriber's details are temporarily stored in the VLR (14A) of the visited network (I) and the subscriber's location is stored in the HLR (10) of the home network (III), thereby enabling the calls to be routed to and from the visiting subscriber (MS 20III). The calls themselves are not routed via the international roaming platform (IRP 30).



TELECOMMUNICATIONS ARRANGEMENTS AND METHODS

The invention relates to telecommunication arrangements and methods. In one particular application, to be described in more detail below by way of example only, a telecommunication arrangement embodying the invention comprises GSM cellular telephone networks in which the subscribers to one of the networks can make and receive calls when temporarily present in the other network. However, the invention is not limited to such applications.

According to the invention, there is provided an interconnection unit for interconnecting each of a plurality of telecommunications networks with a selected one of the others thereof, the unit including means for receiving data relating to the subscriber to one of the networks ("home network") when present in another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

According to the invention, there is further provided a telecommunications arrangement, comprising a plurality of

networks ("home network") while visiting another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

According to the invention, there is further provided a method of interconnecting predetermined ones of a plurality of geographically separate mobile telecommunications networks each having a respective set of subscribers, comprising the steps of responding at a geographical location separate from the predetermined networks to a registration request from a mobile telecommunications unit of the subscriber to one (the "home network") of the predetermined networks while visiting another one ("visited network") of the predetermined networks by confirming that the visited network and the home network are included within the predetermined networks; transmitting the registration request to the home network; and transmitting authentication data from the home network to the visited network via the geographical location for use in authenticating the mobile telecommunications unit in the visited network to enable calls to be made to and from that mobile telecommunications unit via the visited network.

suitable radio link. As shown in the Figure, MSC 12A controls base stations 16A,16B and 16C. Each base station transmits and receives radio signals within a respective geographical area or cell in which mobile or portable telephones may be located. The Figure shows the cell 18 associated with base station 16A, and also shows three mobile or portable telephones (mobile stations or MSs) 20I,20II and 20III. For clarity, the base stations for the MSCs 12A and 12B are not shown, and neither are the cells for the base stations 16B and 16C. In practice, of course, a network of reasonable size will have many more than three MSCs and may have more than one HLR.

Each MS comprises a portable telephone which is activated by means of a smart card (SIM), each SIM being particular to one subscriber and carrying information identifying that subscriber including the subscriber's IMSI, authentication data and other data. It will be assumed that MS 20I is a portable telephone which has been activated by the SIM of a subscriber to network I, and the operations carried out in relation to MS 20I will now be briefly considered.

When the MS 20I is powered up, a radio signal is transmitted to base station 16A and passed to MSC 12A. The MSC checks whether

In addition, HLR 10 has recorded the current location of MS 20I. Incoming calls to network I intended for the subscriber can therefore be directed by the HLR to MSC 12A and thence to MS 20I. Such calls are directed to MSC 12A and hence to MS 201 by means of the subscriber's public telephone number.

The authentication process described above will be repeated at regular intervals while MS 20I remains activated and can also be repeated each time MS 20I makes or receives a call.

If MS 20I moves into a cell controlled by a base station associated with one of the other MSCs 12A and 12B, the registration process described above will have to be repeated, in order that the subscriber's details are transferred by HLR 10 into the appropriate VLR (14A or 14B). The subscriber's data previously stored in VLR 14A is deleted.

There are a large number of GSM networks throughout the world (over 200 at present). It is obviously desirable that a subscriber to one such network is also able to make and receive calls when present in one of the other networks. If this is to be possible, it is necessary for the visited network to be able to establish satisfactorily that the visiting subscriber is

subscriber as being a subscriber to network II. MSC 12A will therefore be aware that the subscriber's data will not be present in HLR10 of network I. The MSC will therefore interrogate HLR 10 in network II by means of a suitable link to a gateway unit 22 in network I, a landline or other link 24 (such as provided by the relevant PTT), and a further gateway unit 22 in network II. Using the subscriber's IMSI, HLR 10 in network II will access the storage location respective to that subscriber and will respond initially by producing the "challenge" and "response" data in similar fashion to that described above. This data will be passed back to MSC 12A in network I and used to check the authentication of MS 20II in cell 18 of network I in the manner already explained in relation to MS 20I. Assuming that correct authentication takes place, the HLR 10 in network II continues by sending data to MSC 12A in network I defining the subscriber's service entitlement together with other data, all of which is then stored in VLR 14A of network I. In this way, MS 20II can now make calls while present in network I.

HLR 10 in network II will store the current location of MS 20II. Incoming calls for MS 20II will initially be received by network II - because it is to that network that they will be addressed by use of the subscriber's telephone number. However, HLR 10 of

to roam into every other GSM network, there needs to be an appropriate agreement between network I and each of the other networks. If roaming is to take place as described above with reference to networks I and II, this would necessitate a separate bilateral roaming agreement between network I and each other network; correspondingly, each of the other networks would need to make bilateral agreements between themselves to enable their subscribers to inter-roam. However, it may not be appropriate or cost-effective for small networks (e.g. in small or low-populated countries) to conclude such a large number of bilateral agreements. The Figure therefore illustrates an alternative arrangement in accordance with the invention which will now be described. It will be assumed that networks III and IV are networks (e.g. small networks or networks in countries with low population) which have not concluded any bilateral roaming agreements, at least with networks I and II.

Network III is constructed generally similarly to networks I and II and corresponding items are similarly referenced. In the case of network III, however, it is assumed that it has only a single MSC 12 serving base stations 16A,16B,16C.... In principle, of course, it could have more MSCs. Network III shows an MS 20III which is assumed to be a portable telephone activated by a SIM

take place, as will now be described.

The operations carried out by the IRP 30 when a subscriber to network III roams into network I will first be considered. More specifically, it will be assumed that MS 20III is temporarily present (as shown in the Figure) in cell 18 of network I and is powered up.

When MS 20III in network I is powered up, an appropriate signal will be sent to MSC 12A in network I via base station 16A. The IMSI generated by MS 20III will include data identifying the subscriber as being a subscriber to network III. MSC 12A in network I will therefore be aware that the subscriber is not a "home" subscriber (that is, a subscriber to network I) and that the subscriber's data is not held in HLR 10 of network I. In fact, the MSC will be aware that the subscriber's details are held in network III and that this network has a service agreement with the IRP 30. An interrogation signal is therefore sent to gateway 22 of network I and is initially addressed to IRP30 with a destination address of network III. Thus, the gateway 22 of network I initially addresses the interrogation signal to IRP 30 to which it is sent via a suitable link 32 (e.g. an international telecommunications link provided by the relevant PTT) where it

links 32 and 38 and the relevant gateway units. HLR 10 in network III responds by returning data to MSC 12A in network I defining the subscriber's entitlement to service, this data again being passed via IRP 30 and the links 32 and 38. All this data is temporarily stored in VLR 14A of network I so as to enable MS 20III in cell 18 to make calls in the manner already described. Furthermore, HLR 10 in network III has recorded the current location of MS 20III (within the coverage provided by MSC 12A). Any calls for MS 20III will be received initially by network III which then re-directs them to MS 20III in cell 18 of network I, again using a temporary network I public telephone number provided for this purpose by network I.

Calls for MS 20III in network I are not routed from network III to network I via the IRP 30 but are sent through another link which may, for example, be a normal international telecommunications link between the country of network III and the country of network I.

The registration process described above takes place each time the MS makes or receives a call. If MS 20III moves out of cell 18 into a cell controlled by one of the other MSCs 12B,12C in network I, it is again necessary for the registration process to

It will be appreciated that there may be more than one IRP 30. Thus, each IRP 30 may serve a particular group of networks - such as the networks in a particular geographical region or perhaps a large country or continent. If a subscriber to a network which has concluded a service agreement with one of these IRPs is roaming in a network which has concluded a service agreement with a different IRP, interrogation, authentication and the other control data is passed between the networks via both IRPs. In this case, a corresponding service agreement will have been concluded between the two IRPs. The operation is otherwise as already described.

It will be noted that the IRP 30 stores no information itself relating to any of the subscribers but merely checks whether the network of the roaming subscriber, and the visited network, have concluded service agreements with the IRP.

The IRP 30 may also be used to carry out certain other functions.

Firstly, it may be useful in detecting fraudulent or potentially fraudulent activity by subscribers.

It is normal in international roaming for network operators to

The IRP30 is also aware of the number of calls passing to and from each network. It can use this information to detect faults. Thus, if there appears to be an unusual gap in the frequency of calls to or from a particular network, this may indicate a fault or failure in the link between the IRP and that network and can be used to provide a warning of that fault and to initiate rectification action.

Although the description has stated that all the networks are similar GSM networks, this is not essential. The IRP 30 can in principle be used where one or some of the networks is different from the other. For example, one or some of the networks can be a network operating according to a specification which is different from the others (e.g. one network could be a Japanese PDC network or a United States digital network) and the others could be GSM networks. It is also not necessary for all the networks to be terrestrial networks: one or some of them could be a non-terrestrial network such as a satellite network. The IRP 30 could incorporate means for converting from the format applicable to one network to the format applicable to the other networks.

6. A unit according to any one of claims 1 to 3, in which the networks are dissimilar terrestrial networks.

7. A unit according to any one of claims 1 to 3, in which at least one of the networks is a terrestrial network and at least one other one thereof is a non-terrestrial network.

8. A telecommunications arrangement, comprising a plurality of geographically separate mobile telecommunications networks each having a respective set of subscribers; an interconnection unit connectable between predetermined ones of the networks; means in one (the "visited network") of the predetermined networks operative in response to data representing a registration request from a mobile telecommunications unit of the subscriber ("visiting subscriber") to another one (the "home network") of the predetermined networks while visiting the visited network to transmit the registration request to the interconnection unit; means in the unit for confirming that the visited network and the home network are included within the predetermined networks and for transmitting the registration request to the home network; and means in the home network for transmitting authentication data to the visited network via the interconnection unit for use in authenticating the mobile telecommunications unit in the

relation to the location where the visiting subscriber's mobile telecommunications unit is present, and means in the home network for storing the location in the visited network of the visiting subscriber's mobile telecommunications unit to enable calls received by the home network for that subscriber's mobile telecommunications unit to be routed to that unit in the visited network.

15. An arrangement according to any one of claims 8 to 14, including means in the interconnection unit responsive to repeated registration requests from the same visiting subscriber for detecting abnormal or fraudulent activity.

16. An arrangement according to any one of claims 8 to 15, including means in the interconnection unit responsive to registration requests from a particular visited network or for a particular home network and operative to detect abnormality in the frequency of such requests for indicating a possible fault condition.

17. An arrangement according to any one of claims 8 to 16, including means in the interconnection unit for detecting errors in data received by the unit and for correcting the errors or

responsive to the registration request to transmit authentication data to the first network otherwise through the interconnection unit for authenticating that mobile telecommunications unit, and means in the first network for temporarily storing data relating to that mobile telecommunications unit to enable calls to be routed to and from that mobile telecommunications unit in the first network.

22. A method of interconnecting each of a plurality of telecommunications networks with a selected one of the others thereof, comprising the steps of receiving at a location geographically separate from the networks data relating to the subscriber to one of the networks ("home network") while visiting another of the networks ("visited network") and passing that data to the visited network to enable that subscriber to make and receive calls via the visited network.

23. A method according to claim 22, in which the calls are not routed through the said location.

24. A method according to claim 22 or 23, in which the said data includes identification data and data for authenticating the subscriber when present in the visited network.

registration request to the home network; and transmitting authentication data from the home network to the visited network via the geographical location for use in authenticating the mobile telecommunications unit in the visited network to enable calls to be made to and from that mobile telecommunications unit via the visited network.

30. A method according to claim 29, in which the networks are similar terrestrial networks.

31. A method according to claim 30, in which the networks are GSM networks.

32. A method according to claim 29, in which the networks are dissimilar terrestrial networks.

33. A method according to claim 29, in which at least one of the networks is a terrestrial network and at least one other one thereof is a non-terrestrial network.

34. A method according to claim 29, in which each of the networks is a cellular telephone network, and including the step of temporarily storing data in the visited network relating to

38. A method according to claim 37, including the step of detecting the frequency or number of the detected errors.

39. A method according to any one of claims 29 to 38 including the step of converting data received from one of the home and visited networks into the data format corresponding to the other thereof.

40. A method according to any one of claims 29 to 39, in which two of the networks form a pair of the networks in which at least one of the networks in the pair is not a said predetermined network, and including the step of responding in a first one of the pair of networks to a registration request from a mobile telecommunications unit of a subscriber to the second one of the pair of networks while visiting the first network by passing that request directly to the second network, responding in the second network to the registration request to transmit authentication data directly to the first network for authenticating that mobile telecommunications unit, and temporarily storing in the first network data relating to that mobile telecommunications unit to enable calls to be routed to and from that mobile telecommunications unit in the visited network.

The Patent Office

3/

Application No: GB 9703547.1 **Examiner:** Nigel Hall
Claims searched: all **Date of search:** 24 April 1997

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.O): H4L (LDSC)

Int Cl (Ed.6): H04Q 3/00, 7/38

Other: Online: WPI

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2280085 A	(VODAFONE)	
A	WO 95/32592 A1	(SIEMENS)	
A	WO 92/02103 A1	(MOTOROLA)	

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.